SURFICIAL GEOLOGY OF THE ORANGE QUADRANGLE

ESSEX, PASSAIC, HUDSON, AND BERGEN COUNTIES, NEW JERSEY

INTRODUCTION

Surficial deposits in the Orange quadrangle include artificial fill and alluvial, estuarine, and swamp sediments of postglacial age, and glacial sediments of late Wisconsinan age. The glacial sediments include stratified sand, gravel, silt, and clay deposited in glacial lakes and by glacial streams, and till deposited by glacial ice. The stratified glacial sediments are as much as 250 feet thick. Till is as much as 60 feet thick. The postglacial deposits are generally less than 20 feet thick.

The surficial deposits are delineated on the accompanying map and cross sections and are described below. The postglacial and glacial events they record are also discussed. A brief summary of the hydrologic and engineering characteristics of the deposits is also provided. Well and test-boring data used to draw bedrock-surface contours and to infer the subsurface distribution of the deposits are plotted on the map, and selected logs are listed in table 1. Table 2 lists the composition of gravel clasts in the glacial deposits. Figure 1 shows the extent of glacial lakes and ice margins in the quadrangle and adjacent areas. The chronologic relationships of the deposits are shown in the "Correlation of Map

HYDROLOGIC AND ENGINEERING CHARACTERISTICS

Surficial deposits in the Orange quadrangle convey water from the surface to underlying bedrock and to surface-water bodies. They also provide support for foundations, and are the material within which excavations for underground structures and road and railroad cuts are made. Before the 1970s they were mined for sand, gravel, and clay at a few places. The extent of larger recent sand and gravel pits are shown on the map; locations of smaller pits are shown in Merrill and others (1902) and Darton and others (1908). Urbanization now precludes further

Hydraulic conductivities of the surficial deposits can be estimated from statewide glacial aquifer-test data on file at the N. J. Geological Survey (www.state.nj.us/dep/njgs/geodata/dgs01-4.htm) and published aquifertest and laboratory data summarized by Stanford and Witte (in press). Sand and gravel deposits (units Qbn, Qwt1, Qwt2, Qbd, Qve, Qah, Qdw, Qyn, Qpr, Qst, and parts of Qal) are highly permeable, having estimated hydraulic conductivities between 10^1 and 10^3 feet per day (ft/d). Silt and clay lake-bottom deposits (parts of units Qbnl, Qwt1, Qvel, and Qdwl) are of low permeability, having estimated hydraulic conductivities of 10⁻⁵ to 10⁻³ ft/d. Fine sand and silt lake-bottom and alluvial deposits (parts of units Qbnl, Qvel, Qwt1, Qdwl, and Qal) and sandy silt till (units Qr, Qry) are somewhat more permeable, having estimated hydraulic conductivities of 10⁻³ to 10⁻¹ ft/d. Salt-marsh and swamp deposits (Qm and Qs) and fill have variable hydraulic conductivities that depend on the clay and silt content of the material. Salt-marsh and swamp peats with little mineral soil, and fill composed of sand, cinders, gravel, demolition debris, slag, and trash, may be highly permeable.

The strength of the surficial materials depends on their grain size, compaction, and water content. Salt-marsh, swamp, and alluvial deposits (units Qm, Qs, and Qal) are of low strength because they have not been subject to water or sediment loads greater than those at present, and have been continuously saturated or moist since their time of deposition, and so are noncompact. They also may contain significant amounts of organic matter, which is weaker than mineral soil. Construction on these materials generally requires the use of pilings to transfer loads to the underlying bedrock or till, or the excavation of the natural material and replacement with engineered fill of greater strength. Lake-bottom deposits that underlie units Qm, Qal, Qpt, and Qs (units Qbnl, Qdwl, and parts of Qwt1) are similarly of low strength because they have been continuously saturated since deposition.

Sand and gravel (units Qbn, Qwt1, Qwt2, Qve, Qdw, Qyn, Qbd, Qah Qst, Qpt) are coarser-grained and, where they crop out, better-drained than the lake-bottom, alluvial, and wetland deposits and thus are of greater strength. Most till (Qr, Qry) in the quadrangle was deposited beneath glacial ice and so has been consolidated by the weight of the ice. Artificial fill consists of a variety of materials, including uncompacted trash and demolition debris, and compacted engineered fills composed of sand, silt, and gravel. Uncompacted fill, and fill containing wood, decomposable material, or void space, is subject to settlement. Fill placed on top of salt-marsh, alluvial, or swamp deposits is also subject to settlement because the underlying materials are highly compressible.

Data on the density, grain size, and Atterberg limits for the surficial materials are provided by Rogers and others (1951).

DESCRIPTION OF MAP UNITS

Postglacial Deposits--These include man-made fill, sediment deposited in salt marshes (Qm), in freshwater swamps (Qs), and in river floodplains and channels (Qal, Qpt, Qst). They were all deposited after glacial retreat.

After glacial Lake Bayonne lowered to the Hackensack level (see below), and after the sediment dams for lakes Delawanna and Paramus that blocked the Passaic Valley at Kearny and Rutherford (fig. 1) were eroded, the Passaic River cut a channel into the deltaic sand in the valley between Newark and Paterson. This sediment was redeposited as a terrace (Qpt) on the valley bottom. Draining of Lake Hackensack caused the Passaic to cut its channel into the terrace sand and to deposit sandy alluvium (included in unit Qal) along its present channel and on the drained Lake Bayonne-Hackensack lake bottom. This alluvial sand is now covered by salt-marsh deposits and fill in the salt marsh east of Kearny (hereafter referred to as the "Kearny Meadows") (section EE'). Similarly, draining of glacial lakes Verona, Watsessing, and Yantacaw exposed deltaic deposits to erosion by the Peckman, Second, and Third rivers, resulting in the deposition of small stream terraces (Qst) along those rivers.

As the erosion of the deltas was completed the sediment load in the streams declined. The terraces themselves were then incised and the modern floodpain and channel sediments (Qal) were laid down. In the Kearny meadows, alluvial deposition was gradually replaced by saltmarsh sedimentation (Qm) as sea level rose and flooded the former lake plain. Most of the salt-marsh sediment has been deposited within roughly the past 3000 years (Newman and others, 1969).

Landfilling on the wetland and alluvial deposits began shortly after permanent European settlement in the 1600s. The earliest fills were likely along the Newark and Harrison waterfronts. Large-scale filling for transportation, industrial facilities, and residential development occurred during the early twentieth century. Much of the original salt marsh, most former river floodplains, and virtually all of the original freshwater swamps have been filled.

- ARTIFICIAL FILL--Artificially emplaced sand, gravel, silt, clay, and rock fragments; and man-made materials including cinders, ash, brick, concrete, wood, slag, metal, glass, and trash. Color variable but generally dark brown, gray, or black. As much as 60 feet thick but generally less than 20 feet thick. Mapped only where it covers salt-marsh, alluvial, or swamp deposits, and where it occurs in distinct landforms visible on 1:12,000-scale aerial photographs. Fill is also present in all urban areas as a layer generally less than 10 feet thick. The extent of fill is based, in part, on the extent of swamps, alluvial deposits, and salt marshes shown in Salisbury (1895), N. J. Geological Survey (1889, 1906), Merrill and others (1902), and Darton and others (1908).
- SALT-MARSH DEPOSITS--Organic silt and clay, and peat; black, dark brown, and gray. As much as 15 feet thick.
- ALLUVIUM--Sand, silt, pebble-to-cobble gravel, minor clay; dark brown, gray, reddish-brown. Contains variable amounts of organic matter. As much as 25 feet thick. Extent of alluvium beneath artificial fill is based, in part, on mapping by Salisbury (1895), Merrill and others (1902) and Darton and others (1908). Many small deposits of alluvium along streams and in valley bottoms in urban areas, now covered by fill, are not mapped.
- SWAMP DEPOSITS--organic silt and clay, and peat; black, dark brown, and gray. As much as 10 feet thick (estimated). Except for the small swamp in Eagle Rock Reservation, the deposits are inferred from historical maps (N. J. Geological Survey, 1889, 1903) and are now entirely covered by fill.
- LOWER PASSAIC TERRACE DEPOSITS--Fine-to-coarse sand, some silt and pebble gravel; light reddish-brown, light gray, very pale brown. Moderately to well-sorted; stratified. As much as 40 feet thick.
- STREAM TERRACE DEPOSITS--Fine-to-coarse sand and pebble-to-cobble gravel, some silt; reddish-brown to brown. Moderately sorted; stratified. As much as 15 feet thick (estimated).

Glacial Deposits--These include till--a poorly sorted, nonstratified sediment containing gravel clasts and boulders, deposited directly from glacial ice (Qr, Qry), and sorted, stratified sediments. The stratified sediments include sand and gravel laid down by glacial meltwater in river plains (Qeb, Qbd), and in glacial-lake deltas and fans (Qbn, Qdw, Qwt1, Qwt2, Qyn, Qah, Qpr); and varved silt, clay, and fine sand deposited on the bottoms of glacial lakes (Qbnl, Qwt1, Qvel, Qdwl,

Before these deposits were laid down the underlying bedrock surface was shaped by glacial erosion. The topography of the bedrock surface (plotted at 50-foot contour interval on the geologic map at and below the 200-foot elevation) shows elongate northeast-southwest-trending troughs that extend to nearly 300 feet below sea level in the Kearny meadows, and to nearly 100 feet below sea level in the Passaic Valley. The troughs shallow both northward and southward (Stanford and others, 1990) and are closed to an elevation reaching just below sea level, indicating that they are products of glacial scour, not filled preglacial valleys.

The bedrock valley extending southwestward from Nutley to Orange may be, in part, a preglacial fluvial valley. Deposition of stratified sediments in glacial Lake Watsesssing and deposition of the Bloomfield Moraine (unit Qrb) blocked the valley during deglaciation. When stream drainage was reestablished, the Second River was diverted eastward from its former valley at Bloomfield, and the Third River was diverted northeastward at Bloomfield into the Nutley-Bloomfield segment of

Till is generally thin (less than 35 feet thick) throughout most of the broad upland areas between the valleys, indicating that the topography of these uplands is the product primarily of glacial erosion rather than deposition. The northeast-southwest-trending streamlined ridges indicated by the bedrock topography east of First Watchung Mountain were produced chiefly by differential glacial erosion of the northeastsouthwest striking beds of sandstone and siltstone in this area. Where till exceeds 40 feet in thickness (wells 8, 10, 20, 37, 148, 167, 187) deposition of till contributed to the streamlining.

The distribution and composition of till reflect ice-flow directions during the late Wisconsinan glaciation. Regionally, striation and drumlin orientations indicate that late Wisconsinan ice advanced southerly to southwesterly across northeastern New Jersey as a lobe channeled between the Watchung Mountains on the west and the Palisades Ridge on the east, and centered on the Hackensack Valley (Salisbury, 1902; Stanford and Harper, 1991). The Orange quadrangle is located on the west side of this lobe. East of First Watchung Mountain ice flowed southwesterly, whereas on and west of First Mountain, striations demonstrate a more westerly flow imparted as ice from the east overtopped the ridges. This ice had traversed extensive outcrops of red sandstone and siltstone to the northeast in the Hackensack Valley and it deposited primarily reddish-brown silty sand till (Qr), reflecting the red sandstone source rocks. Yellowish-brown silty till (Qry) was deposited on Second Watchung Mountain and on First Mountain north of Cedar Grove Reservoir. The yellow color and higher silt content of this till reflect the incorporation of weathered basalt as ice traversed First Mountain.

Late Wisconsinan ice reached its southernmost position at Perth Amboy, about 20 miles south of Belleville, about 21,000 yrs B.P. (radiocarbon years before present), based on radiocarbon dates of organic material in bogs in western New Jersey (Harmon, 1968; Cotter and others, 1986) and on organic sediments beneath till on Long Island (Sirkin, 1986). A continuous terminal moraine was deposited at the position of maximum advance. As the ice front retreated, a series of glacial lakes formed, dammed to the south by the moraine (Stanford and Harper, 1991). One of these, Lake Bayonne, occupied the Newark Bay and Hackensack Meadows lowlands (fig. 1) and had an outlet over the moraine at Perth Amboy. This outlet was gradually lowered by erosion, and therefore the level of Lake Bayonne steadily declined. In the Orange quadrangle a delta deposited in Lake Bayonne at Newark records a lake level of about 30 feet above sea level. Adjusting for postglacial rebound of Earth's surface in response to release of the weight of the glacier, this elevation indicates that the spillway at Perth Amboy had been eroded to about 25 feet below sea level (using the rebound rate of 3.5 feet per mile to the north from Stanford and Harper [1991]). Deposits in Lake Bayonne include deltaic and lacustrine-fan sand and gravel (Qbn), and lake-bottom silt, clay, and fine sand (Qbnl).

Continued erosion of the outlet at Perth Amboy, and along the Arthur Kill to the north, uncovered diabase bedrock at an elevation of 30 feet below sea level in the Arthur Kill about 15 miles south of Belleville. The diabase halted further downcutting and formed the stable spillway for Lake Hackensack. An auxiliary spillway was also established across diabase in the Kill van Kull between Bayonne and Staten Island. In the Orange quadrangle, Lake Hackensack occupied the lowest parts of the Kearny meadows. The upper parts of the lake-bottom silt and clay deposit underlying the meadows were likely laid down in Lake Hackensack (Qhkl). The lake drained eastward into the Hudson Valley when the retreating ice front uncovered Sparkill Gap, a deep gap through the Palisades Ridge, about 20 miles northeast of Belleville.

As the ice front retreated eastward into the Second River Valley, deposition of a glaciofluvial deposit (Qeb) by meltwater draining down the East Branch of the Rahway River Valley was succeeded by deposits laid down in glacial Lake Watsessing (Qwt1, Qwt2, Qwt1) (fig. 1). This lake was initiated when the ice front retreated eastward from the Rahway-Second River divide and water was impounded in the eastdraining valley. Earlier, higher stages of Lake Watsessing (combined as stage 1 in fig. 1) were controlled by an initial spillway into the Rahway basin at an elevation of about 190 feet, succeeded by 2 or 3 spillways into the Elizabeth River basin at elevations between 165 and 175 feet. Sand and gravel deposited in this lake stage (Qwt1) do not clearly show lakeshore features and so cannot be tied to a particular spillway. However, both of the Qwt1 deposits rise to elevations above 180 feet and so were probably laid down when the 190-foot spillway was active. With continued eastward retreat of the ice margin, a lower spillway at an elevation of about 110 feet was uncovered in what is now Branch Brook Park. It drained southerly into Lake Bayonne in the Passaic Valley (fig. 1). A broad but thin delta (Qwt2) was deposited in this shallow lake stage (stage 2 in fig. 1). When continued retreat uncovered the Second River Valley between Newark and Belleville,

The Bloomfield Moraine (Qrb) was deposited concurrently with Qwt2 and with the Lake Bayonne deltaic deposit (Qbn) in north Newark This moraine, which is composed of both till and sand and gravel, represents a significant stillstand of the receding ice margin and appears to correlate to the Silver Lake and Ogdensburg-Culvers Gap moraines farther west in the state (Stanford, 1993). Moraine deposits may overlie deltaic sediment in places (sections BB', CC', well 128), suggesting that the ice margin may have readvanced a short distance during or prior to deposition of the moraine.

During, or shortly after, deposition of the Bloomfield Moraine, the receding ice margin on First Mountain uncovered Great Notch, a gap in the mountain at an elevation of about 300 feet. This allowed glacial Lake Passaic, a large lake that filled the Passaic basin between Second Mountain and the Highlands, to drop from a high stage (the Moggy Hollow stage, fig. 1) to the Great Notch stage (fig. 1) (Salisbury and Kummel, 1895; Stone and others, 1989). This was a drop of about 75 feet in lake level and it likely produced a large initial flood down the Third River Valley, which drains the Great Notch spillway, followed by a steady spillway discharge until the gap through First Mountain in Paterson was uncovered, at which time the lake drained. This flood and subsequent discharge cut channels into the upland downstream from Great Notch. The main channel is particularly evident along Third River between Grove and Broad streets. A slightly smaller channel formed either as an overflow channel during the initial flood or as an earlier channel when the ice front was a little farther west, descends through Yanticaw Brook Park in Montclair. Where the slope of the valley flattens near Brookdale, a plain of sand and gravel was deposited. This glaciofluvial deposit (Qbd) extends downvalley to Bloomfield, where it overlies lake-bottom sediments of Lake Watsessing (sections BB', CC').

As the ice front receded eastward from the Bloomfield Moraine, several additional glacial lakes formed. In the Passaic Valley the Lake Bayonne delta filled the valley in the reach south of the junction of Second River to an elevation of about 50 feet. This delta formed the dam for glacial Lake Delawanna (fig. 1), which filled the Passaic Valley between Belleville and Passaic as the ice front retreated eastward. Deltaic sand and gravel (Qdw) were deposited in this lake in the Clifton-Passaic area and in Belleville, and lake-bottom silt, fine sand, and clay (Qdwl) accumulated in the Lyndhurst-Belleville reach of the valley (section DD').

The Third River Valley downstream from Bloomfield drains northeasterly and so was dammed by the retreating ice margin to form glacial Lake Yantacaw (fig. 1). This lake was controlled by a spillway at an elevation of about 110 feet just north of Hendricks Field in Belleville, with southward drainage into the Second River Valley. Deposits in Lake Yantacaw are chiefly sand and silt deltaic sediments

A small easterly draining valley near Athenia was similarly dammed, forming glacial Lake Athenia (fig. 1). Deltaic sand and gravel (Qah) largely fill this lake basin.

Continued northeasterly retreat of the ice margin out of the Orange quadrangle left a delta in the Delawanna section of Clifton as a dam across the Passaic Valley at an elevation of about 35 feet just north of the present crossing of Route 3. Lake Paramus (fig. 1) formed in the Passaic and Saddle River valleys north of this dam. A small part of a glacial Lake Paramus delta (Qpr) occupies the extreme northeastern corner of the quadrangle.

In the north-draining Peckman River Valley, between First and Second mountains in the northwestern part of the quadrangle, the northwardretreating ice margin dammed the valley to create glacial Lake Verona (fig. 1). Lake Verona was controlled by a spillway at an elevation of about 400 feet on the West Branch Rahway River-Peckman River divide. Deltaic sand and gravel (Qve) and lake-bottom silt and clay (Qvel) were deposited in this lake, which was more than 200 feet deep in places. When the retreating ice margin uncovered the north end of Second Mountain in North Caldwell, Lake Verona became an arm of the Moggy Hollow stage of Lake Passaic, which was at a nearly identical elevation as Lake Verona. This lake then lowered to the Great Notch stage when Great Notch was deglaciated, and drained completely when the gap in First Mountain at Paterson was uncovered

Glacial-Lake Deposits--These are stratified and generally well-sorted. They include sand and gravel laid down in deltas and lacustrine fans; and clay, silt, and fine sand laid down on lake-bottom plains and in the lower parts of deltas. Bedding in the deltas includes inclined foreset beds of sand, pebbly sand, and minor pebble-to-cobble gravel, overlain at the surface of some deltas by horizontal topset beds of sand and pebble-to-cobble gravel. Lacustrine fans contain gently dipping beds of sand and pebble-to-cobble gravel. Bedding in deltas and lacustrine fans may be deformed locally by collapse, slumping, or pushing by glacial ice. Bedding in lake-bottom deposits is generally horizontal, laminated to thin-bedded, and undeformed. Nongravel sediment is light reddishbrown, reddish-brown, yellowish-brown, and light gray. Sand composition is chiefly quartz, feldspar, mica, and fragments of sandstone, mudstone, gneiss, quartzite, and basalt. Gravel consists chiefly of clasts of red and gray sandstone and mudstone, and a little gray gneiss, white-to-yellow quartz, purple-to-gray quartzite and quartzite-conglomerate and, in the Lake Verona deposits, dark-gray Qhkl GLACIAL LAKE HACKENSACK LAKE-BOTTOM DEPOSITS--Silt, clay, minor fine sand. As much as 40 feet thick (estimated). Lower contact is an approximate timeline marking the transition from the Lake Bayonne level to the Lake Hackensack level, not a physical discontinuity.

Qpr GLACIAL LAKE PARAMUS DEPOSITS--Fine-to-coarse sand, minor pebble gravel. As much as 40 feet thick (estimated).

Gab GLACIAL LAKE ATHENIA DEPOSITS--Fine-to-coarse sand and pebble-to-cobble gravel. As much as 65 feet thick.

sand, silt, minor pebble-to-cobble gravel and clay. As much as

Qyn GLACIAL LAKE YANTACAW DEPOSITS—Fine-to-coarse

GLACIAL LAKE DELAWANNA DEPOSITS--Include deltaic and lacustrine-fan sediment (Qdw) in the Clifton and Passaic area, and a small deposit in Belleville; and lake-bottom sediment (Qdwl) in the Passaic Valley between Newark and Lyndhurst, beneath terrace deposits and alluvium (section DD'), and locally beneath deltaic deposits

Qdw Fine-to-coarse sand and pebble-to-cobble gravel, minor silt. As much as 70 feet thick.

Qdwl Silt, fine sand, clay. As much as 60 feet thick.

(sections AA', BB', CC').

GLACIAL LAKE BAYONNE DEPOSITS--Include deltaic and lacustrine-fan sediment in Newark and Harrison (Qbn) and lake-bottom sediment (Qbnl) beneath alluvium in the Passaic Valley at Newark (section DD') and beneath salt-marsh deposits in the Kearny Meadows

Qbn Fine-to-coarse sand and pebble-to-cobble gravel, some silt. As much as 80 feet thick.

Qbnl Silt, clay, fine sand. As much as 220 feet thick.

GLACIAL LAKE WATSESSING DEPOSITS--Include deltaic and lacustrine-fan sediment deposited in an upper lake stage (Qwt1) and a lower stage (Qwt2), and lake-bottom sediment (Qwt1) deposited in both lake stages.

Qwt2 Fine-to-coarse sand and some pebble gravel and silt. As much as 40 feet thick.

Qwt1 Fine-to-coarse sand, pebble gravel, minor cobble gravel. As much as 80 feet thick.

GLACIAL LAKE VERONA DEPOSITS--Include deltaic and lacustrine-fan sediment (Qve) and lake-bottom sediment (Qvel). Qve Fine-to-coarse sand, pebble-to-cobble gravel, some silt. As

Qvel Silt, clay, fine sand. As much as 90 feet thick.

much as 140 feet thick.

Qwtl | Silt, fine sand, clay. As much as 50 feet thick.

Glacial-Stream Deposits--Stratified, generally well-sorted gravel and sand forming valley-bottom plains and terraces in valleys not occupied by glacial lakes. Bedding is generally horizontal; varying from massive, thick beds in cobble gravel to cross-beds and thin horizontal beds in sand to pebbly sand. Nongravel sediment is reddish-brown, brown, and light-gray. Sand is chiefly quartz, feldspar, mica, and fragments of redbrown sandstone and mudstone, gray gneiss, and gray to purple quartzite. Gravel is chiefly reddish-brown sandstone and siltstone, and some gray-to-brown mudstone and sandstone, gray gneiss, white-toyellow quartz, and purple-to-gray quartzite-conglomerate.

Qbd BROOKDALE DEPOSIT--Pebble-to-cobble gravel and fineto-coarse sand. As much as 40 feet thick.

Qeb EAST BRANCH DEPOSIT--Pebble-to-cobble gravel and fine-to-coarse sand, some silt. As much as 40 feet thick.

Till and Related Deposits--Poorly-sorted, nonstratified sediment deposited directly by glacial ice or by sediment flows from glacial ice.

RAHWAY TILL--Reddish-brown to light-reddish-brown silty sand to sandy clayey silt containing some to many subrounded **Qrt** and subangular pebbles and cobbles and few subrounded boulders. Generally compact below the soil zone. May show a coarse subhorizontal fissile structure. Gravel clasts include chiefly red sandstone and siltstone, some gray sandstone and mudstone, and minor white-to-yellow quartz, gray-to-purple quartzite-conglomerate and gray gneiss. Dark-gray basalt is common on and west of First Mountain. Boulders are chiefly gneiss and gray quartzite; basalt boulders are common on and west of First Mountain. As much as 60 feet thick. Unit Qrt delineates areas where Qr is discontinuous and generally less than 10 feet thick. Contacts with unit Qry are gradational and Qry may underlie Qr in places on and west of First Mountain.

RAHWAY TILL, YELLOW PHASE--Reddish-yellow, ellow, very pale-brown sandy silt to silt with some to many subangular to subrounded pebbles and cobbles and few subrounded boulders. Gravel clasts include chiefly dark-gray basalt, with some red-brown sandstone and siltstone and minor gray sandstone and mudstone, gray gneiss, and gray-to-purple quartzite-conglomerate. Boulders are chiefly gneiss, quartzite, and basalt. As much as 40 feet thick. Unit Qryt delineates areas where Qry is discontinuous and generally less than 10 feet

BLOOMFIELD MORAINE DEPOSIT--Till as in unit Qr nterbedded with fine-to-coarse sand and pebble-to-cobble gravel. As much as 70 feet thick. Forms irregular ridges that stand 20 to 40 feet above adjacent delta and terrace surfaces in Newark, Belleville, and Bloomfield. Some of these ridges are elongated in a northwest-southeast direction, suggesting that they were deposited along one or more recessional ice margins (fig. 1, margins M2 and M3).

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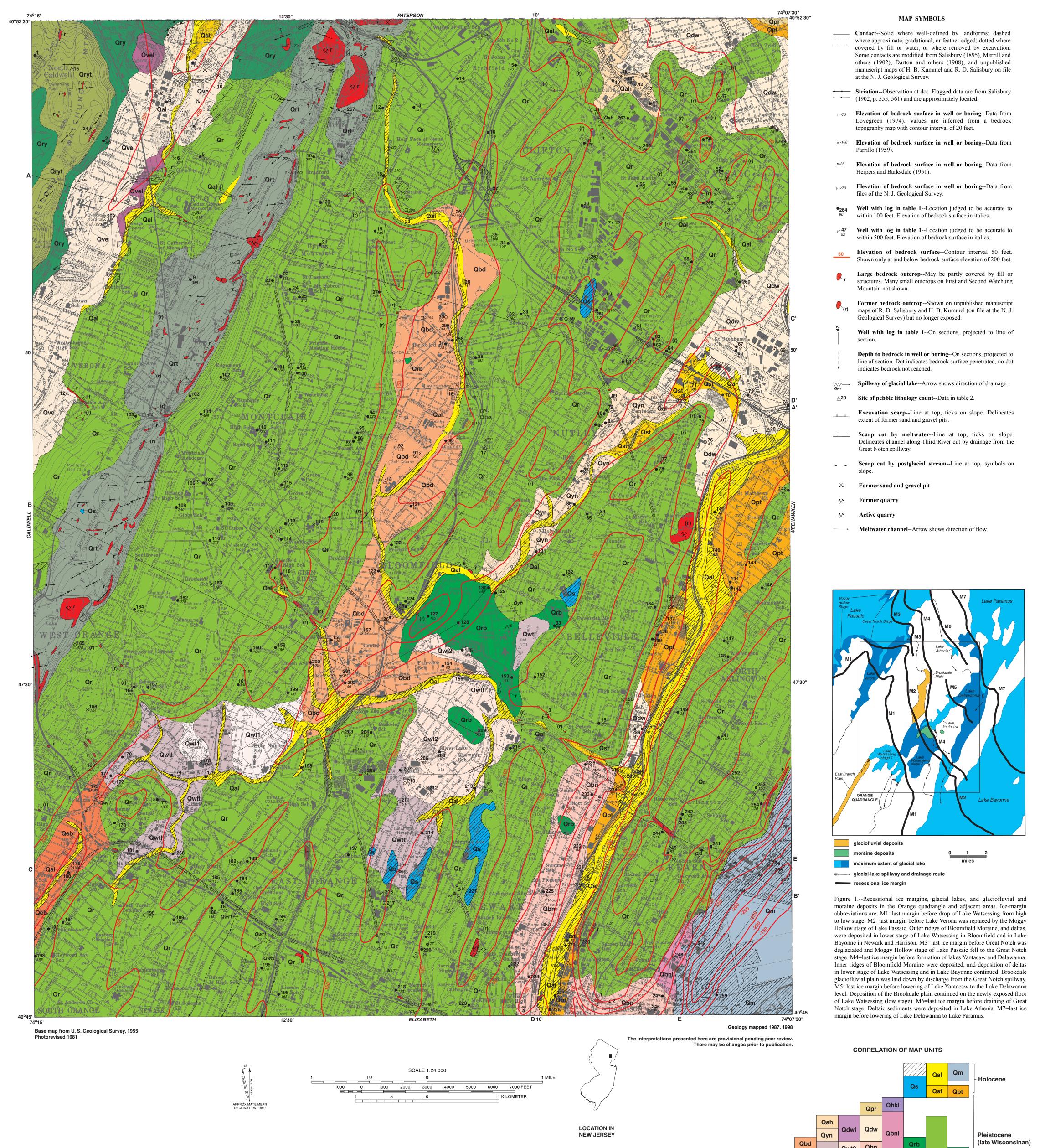
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ESSEX, PASSAIC, HUDSON, AND BERGEN COUNTIES, NEW JERSEY

SURFICIAL GEOLOGY OF THE ORANGE QUADRANGLE,

Scott D. Stanford

SHEET 2 OF 2

gravel, silt, clay, wood fill

sand (Or)

red hardpan (Qr)

wood, sand, silt fill

gray clay, trace silt (Qbnl)

brown peat (Qm)

soft (Qhkl over Qbnl)

gray silt (Qm and Qal)

sand at 120-122 (Qbnl)

fragments and boulders (Qr)

light-brown hardpan (Qr)

brown soil and boulders (Qr)

red sand and clay (Qwtl)

Percentage of pebbles

145-159 fine sand (Qbn)

screened 155-178, yield 65 gpm

250 26-2717

176-186 hard red shale, bedrock

2-44 sand and gravel (Qr)

44-400 red sandstone

159-176 medium sand and gravel, active (Qbn)

dirt (Or)

sandstone

shale

red-brown sand, some silt, little gravel (Qr)

dump fill and meadow mat (Qm)

sandy clay, sand, gravel, glass, brick (fill)

organic soil with some fill settled in (Qm)

gray silty sand, little fine gravel from 20-25 (Qal)

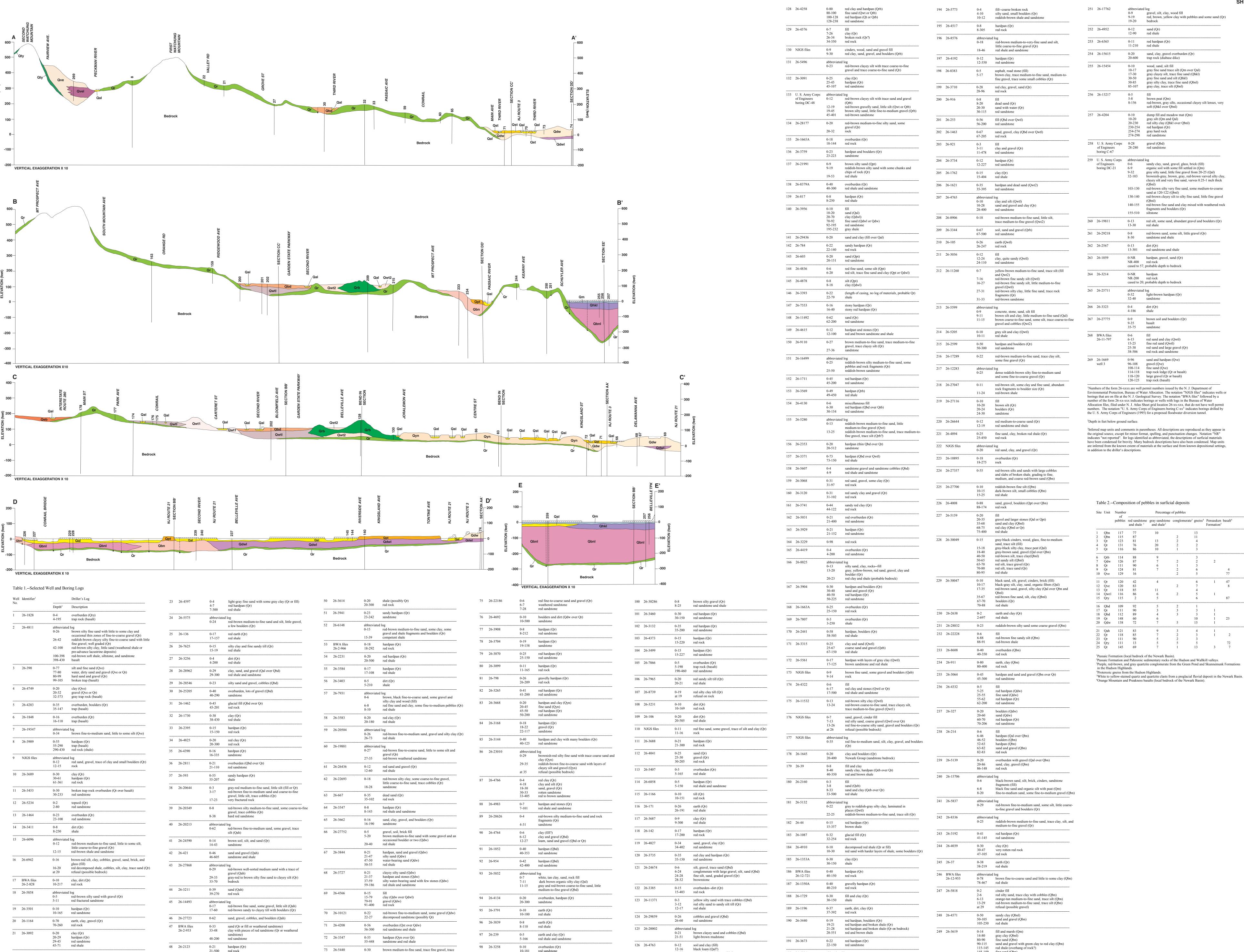
brownish-gray, brown, gray, red-brown varved silty clay.

clayey silt and very fine sand, varves 0.25-1 inch thick

gray fine sand trace silt (Qm over Qal)

gray clayey silt, trace fine sand (Qhkl)

red, brown, yellow clay with pebbles and some sand (Qr)



10-181 red sandstone

0-32 hardpan (Qr)

32-134 sandstone

99 26-3975

16-28 gravel and sandy loam (Qbd)

28-380 red sandstone and shale

0-25 hardpan (Qrb)

25-102 sandstone

127 26-3626

192 26-6996

abbreviated log

11-18 red shale

0-25 red hardpan (Qr)

25-174 red sandstone

0-11 red-brown coarse-to-fine sand and coarse-to-fine

gravel, trace clayey silt (Qr)

73 26-5440

silt (Qdw)

60-304 red rock

0-60 sand and clay (Qdw over Qdwl)

21-500 red rock

0-18 hardpan (Qr)

18-205 red shale

49 26-3195

22 26-23231

abbreviated log

24-28 reddish-brown shale

0-24 reddish-brown silty sand with shale cobbles (Qr)